Explore: Making Sense of Reproductive Strategies

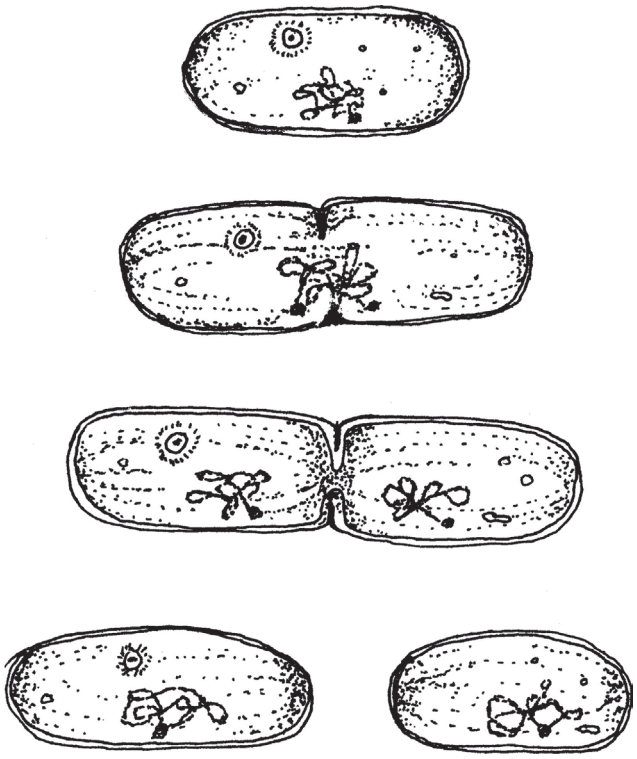
Copymaster 10.1 *Reproduction Cards 1*

EUBACTERIA (example: *Escherichia coil*)

E. coli is just one of the thousands of microscopic (1–10 µm) species of microorganisms in the domain Eubacteria. This particular bacterial species is a beneficial inhabitant of your large intestine, where it synthesizes vitamin K, which is important in the production of blood clotting factors. In other compartments of the body, however, *E. coli* can cause serious infections.

Like other bacteria, *E. coli* reproduce asexually through simple cell division, also known as binary fission. In this process, the genetic material in a bacterial cell is copied, and then the cell elongates and eventually splits (divides) into two cells, each with a copy of the genetic material (DNA). New cells produced in this way are genetically identical to the original.

Under optimal conditions—sufficient space, a good supply of food, appropriate pH and temperature—*E. coli* can divide every 20 minutes. Under those conditions, one bacterium can produce a population of more than 1 million in just 7 hours.

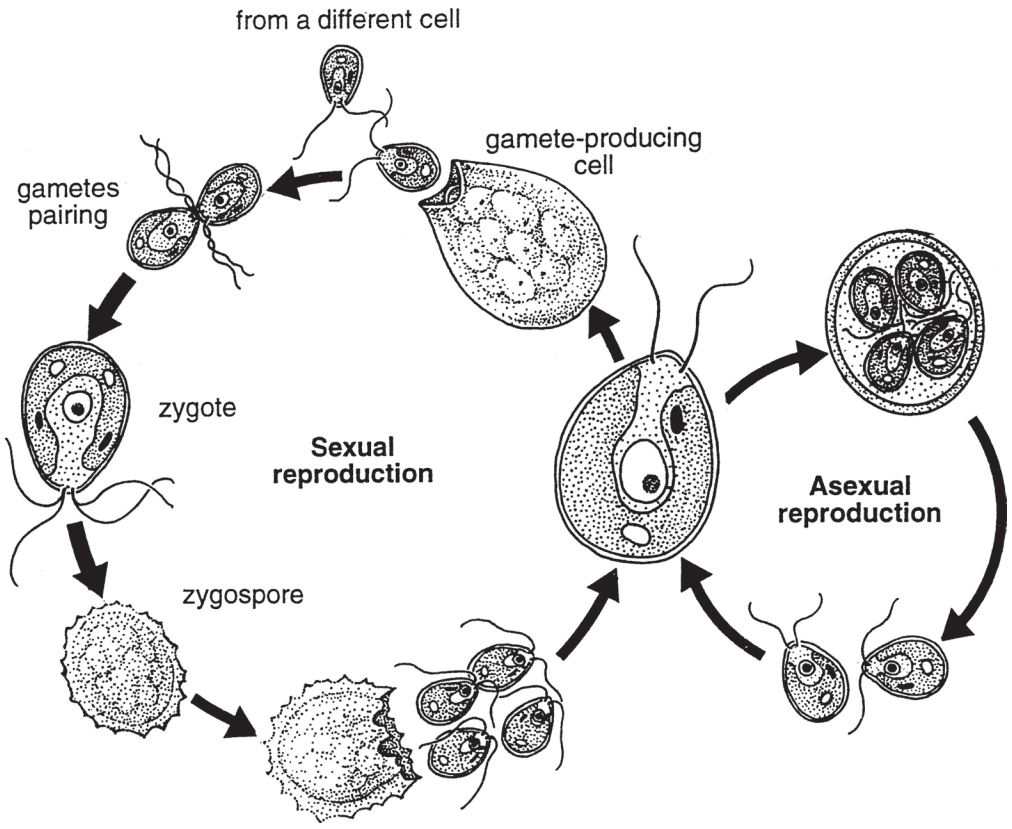


CHLAMYDOMONAS (*Chlamydomonas polypyrenoideum*)

C. polypyrenoideum is a small (20 µm), solitary, free-swimming, photosynthetic protist that is common in freshwater habitats, such as ponds, watering troughs, and birdbaths. It swims rapidly by means of two long, hairlike flagella and has a cell wall around the membrane. Its chloroplast is large and cup-shaped.

C. polypyrenoideum reproduces both asexually and sexually. In asexual reproduction, the nucleus divides to produce up to 16 offspring cells within the parent cell wall. Each cell develops flagella and secretes a wall around itself. The cells then secrete an enzyme that breaks down the parent cell wall by which they can escape.

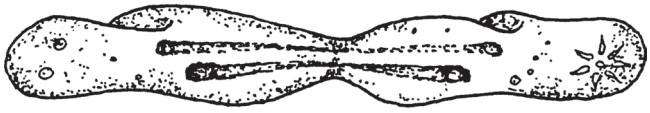
In sexual reproduction, certain cells form gametes, and gametes of different mating types fuse and form a zygote. A thick cell wall forms around the zygote, producing a zygote, or zygospore, that can survive extremes of temperature and dryness. After a period of dormancy, the zygospore divides twice, producing four cells, each of which develops a cell wall and two flagella. These cells either can divide asexually or mate with a cell of another mating strain to produce a new zygote.



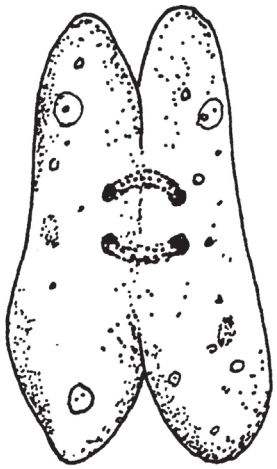
PARAMECIUM (*Paramecium caudatum*)

P. caudatum is a free-living, unicellular protist that is common in freshwater habitats throughout the world. Its distribution and population size in these habitats depend on temperature, acidity, type and amount of food present in the water, and its adaptability to environmental changes. It ranges in size from 180 to 300 µm and moves by means of hairlike structures called cilia. It contains a large macronucleus that is responsible for metabolic activities and a small micronucleus that initiates reproduction. During asexual reproduction, the macronucleus elongates and divides more or less equally, but the micronucleus divides by a process of duplication and equal separation of the genetic material. Following nuclear division, the membrane pinches in and the cytoplasm divides more or less equally.

P. caudatum also reproduces sexually by conjugation. Two individuals of opposite mating types come in contact and, after division of their micronuclei, each conjugant contributes one of its micronuclei to the other. The two micronuclei in each organism then fuse and the conjugants separate. Subsequent divisions of the newly fused micronucleus in each organism lead to the production of four small individuals, each containing a micronucleus and a macronucleus. Conjugation does not occur in well-fed organisms, but may take place shortly after food is depleted. Conjugation takes place only within a certain range of temperatures, and the time between two conjugations varies in different species of *Paramecium*, ranging from a few weeks to several months.



cell division

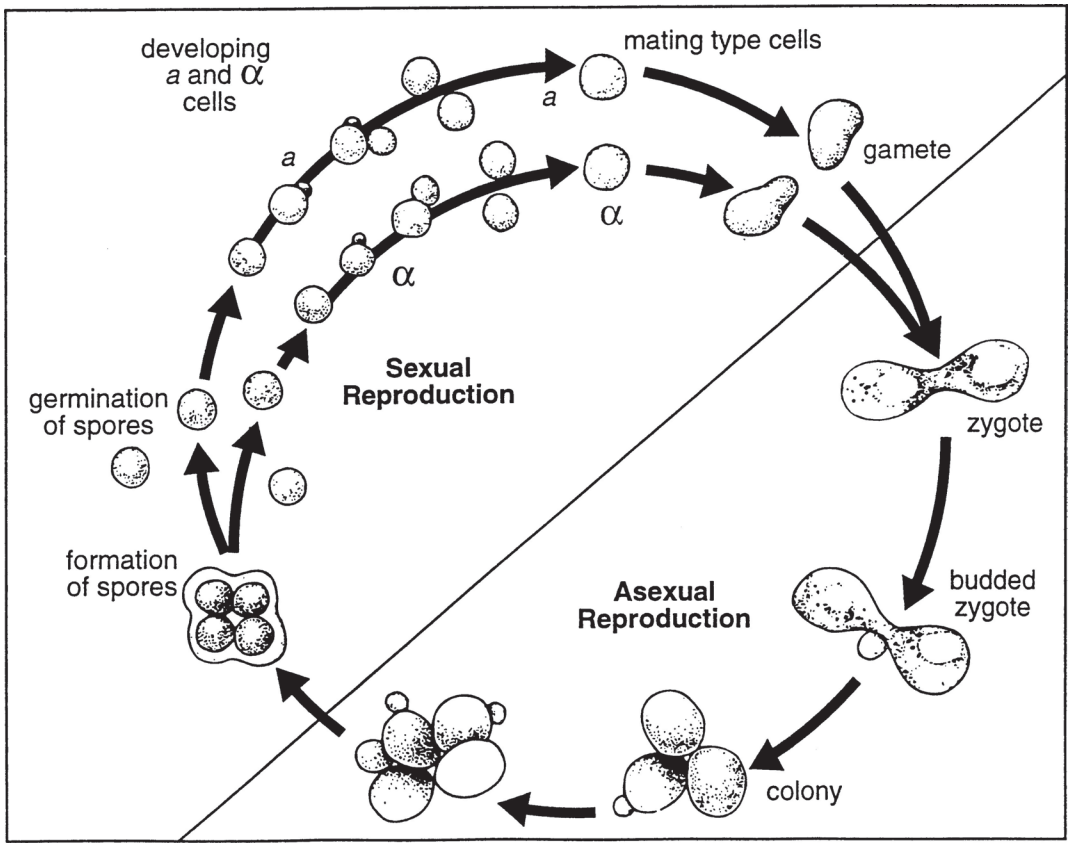


conjugation and fusion of micronuclei

YEAST (example: *Saccharomyces cerevisiae*)

Baker's yeast, *S. cerevisiae*, are microscopic (5 µm), unicellular fungi that grow on fruits and other plant materials. In anaerobic conditions, yeast carry out fermentation, a process that releases alcohol that humans use to make wine and other beverages. Fermentation also releases carbon dioxide, which makes bread dough rise.

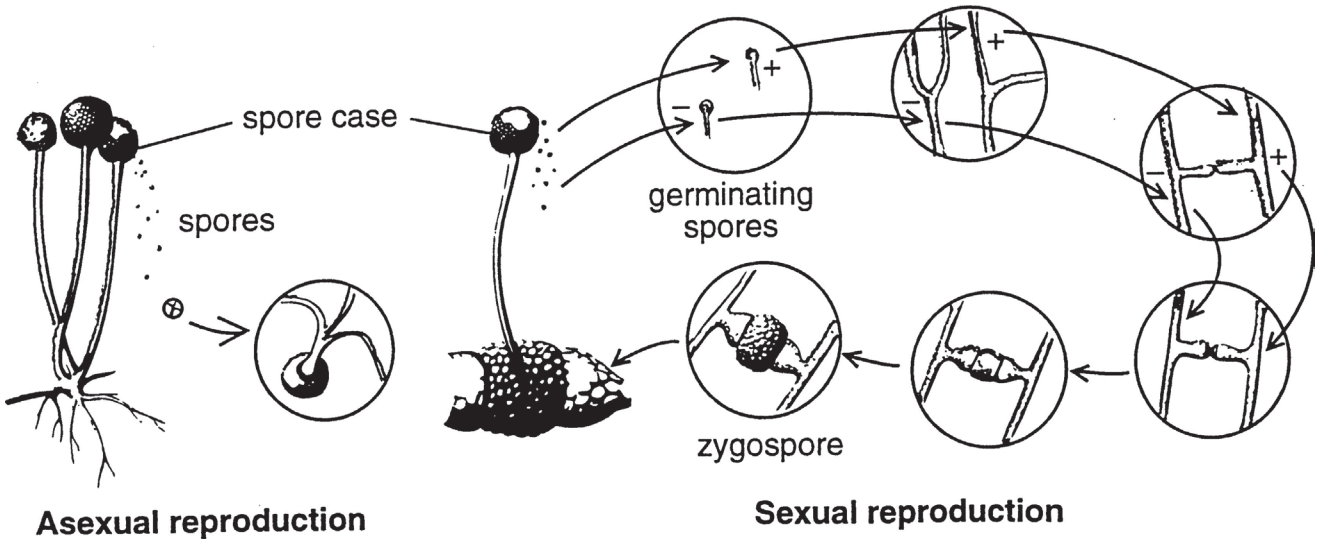
S. cerevisiae reproduces both sexually and asexually. In sexual reproduction, cells of two different mating types come in contact and secrete hormonelike substances that cause cells of the opposite mating type to develop into gametes. The gametes then fuse and form a zygote. The zygotes reproduce asexually by budding. In times of stress, such as during a period of inadequate food supply, cells that are produced from zygotes can undergo a special type of cell division that results in the formation of four spores, two of each mating type. When these cells are released, they can repeat the cycle by developing into gametes and fusing.



BREAD MOLD (*Rhizopus stolonifer*)

R. stolonifer is one of many fungi that live on decaying plant and animal material in the soil. Carbohydrate-rich foods that are exposed to air often develop masses of *R. stolonifer*, which is a serious pest to stored vegetables and fruits. The fungal body is made up of microscopic filament-like structures that are surrounded by a cell wall made of chitin, the same material that forms the exoskeletons of insects. These structures can grow so rapidly that a single fungus can produce a kilometer of new fungal bodies within 24 hours.

Growth begins as a spore that germinates on the surface of bread or fruit and produces these filament-like structures. Some of the filaments push up into the air and form reproductive structures, which eventually break open and release many spores. Each spore can germinate and spread the mold. This type of reproduction is asexual. Sexual reproduction occurs when nuclei from the filament-like structures of two different mating types fuse. The resulting zygotes develop into thick-walled zygospores that can survive periods of stress, such as extreme temperature or dryness. When zygospores eventually germinate, they give rise to sporangia that release spores and begin the cycle again.

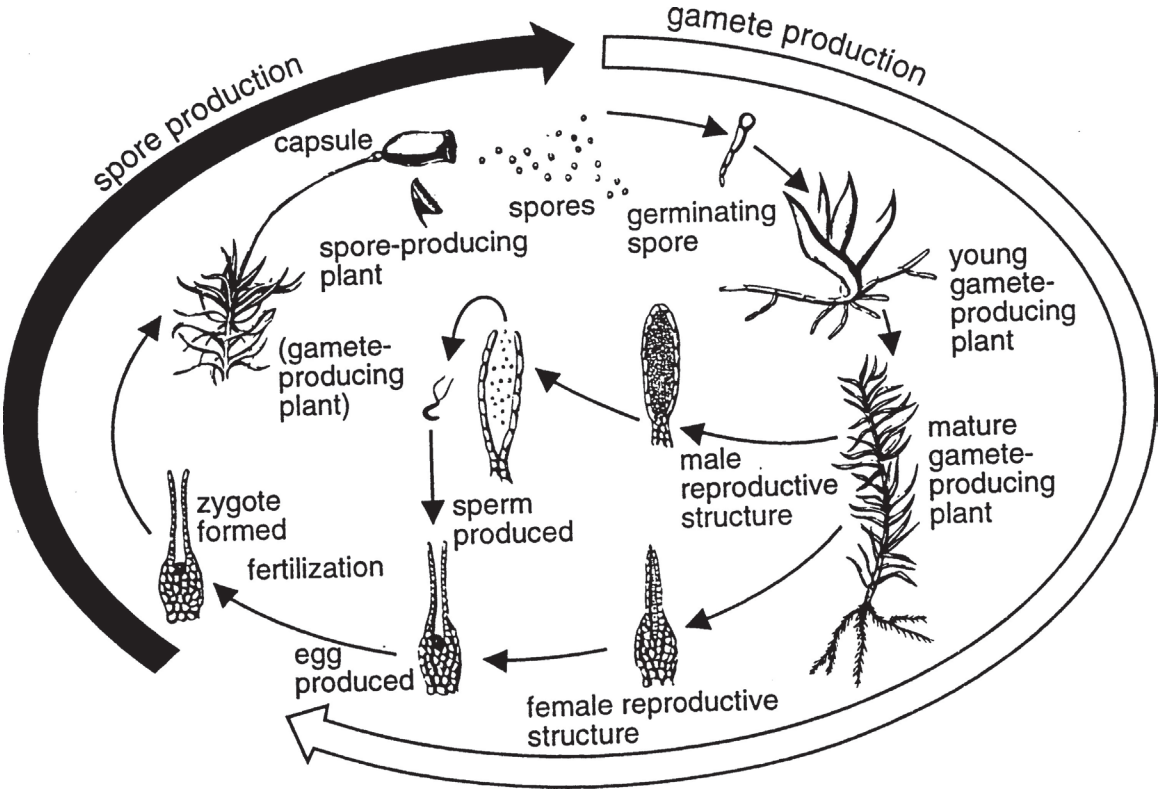


MOSS (example: *Polytrichum juniperinum*)

A carpet of moss actually is many individual plants that have leaflike structures but no vascular tissue. These plants, which generally are no more than 2 centimeters (less than 1 inch) tall, produce gametes in special reproductive structures near their tips. In wet conditions, usually in the spring, male plants produce sperm that swim in a film of water to the egg cells in a female plant. Fertilization results in the formation of a zygote, which develops into a tiny embryo.

In a short time, the embryo grows out of the female plant into a tan, stalklike structure with a capsule at the end. If you look at moss in the spring, you are likely to see many of these reproductive structures. Within the capsule, many microscopic spores are formed. The capsule bursts open and releases the spores, which are carried to wherever wind or water transport them. If a spore reaches a favorable environment—usually a moist soil surface—its wall can burst open. The cell within begins to divide and produce long green threads. Eventually, gamete-producing moss plants develop from these threads.

This method of reproduction is called alternation of generations because a sexual, gamete-producing plant alternates with an asexual, spore-producing plant in the life cycle.

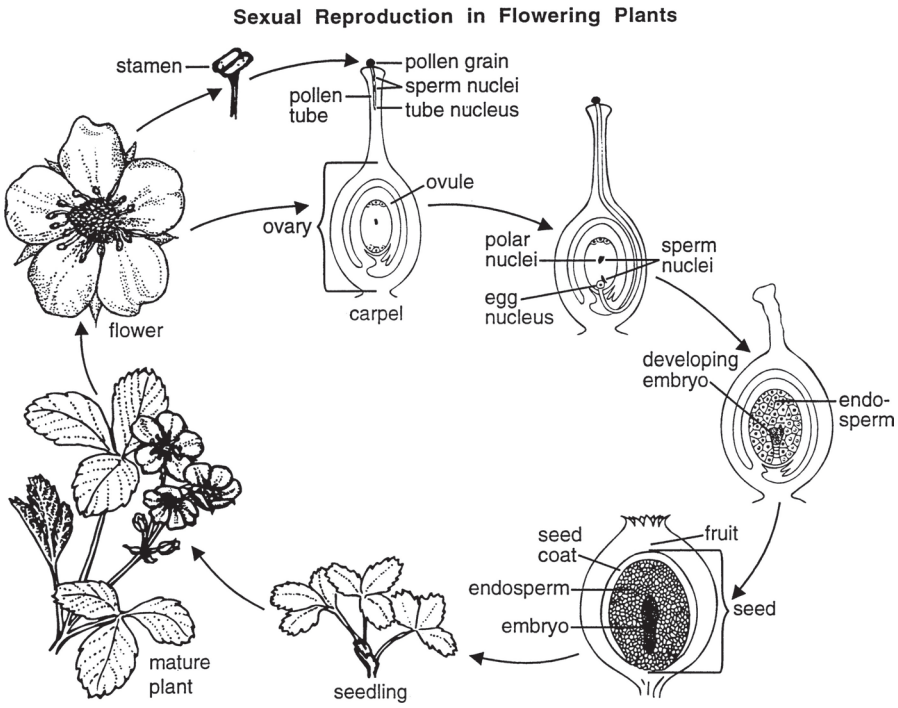


FLOWERING PLANTS (example: strawberry—*Fragaria* spp.)

Flowering plants are the most abundant and widespread of the plants and vary from grasses and tiny violets to large deciduous trees such as oaks. They reproduce by seeds that develop in reproductive structures within flowers. The most conspicuous parts of a flower are the colorful petals, although not all flowers include petals. Just inside the circle of petals is a ring of male reproductive structures, the stamens, which produce pollen grains. Each pollen grain is a thick-walled spore within which two sperm develop. In the center of the flower is the female reproductive organ, the carpel. At the base of the carpel is an enlarged portion, the ovary, that contains one or more small structures called ovules. Within the ovules, four female spores develop. Three of these disintegrate, and the fourth divides three times to form eight nuclei. These nuclei, with their surrounding cytoplasm, form seven cells, one of which is the female gamete, or egg cell. (One of the cells contains two nuclei, the polar nuclei.)

Pollination is the transfer of pollen from the stamens to the carpel by wind, water, or animals. A sticky structure at the top of the carpel traps the pollen grains. Here they germinate and produce a pollen tube that grows down into the carpel and transports the sperm nuclei to the ovule. Fertilization occurs when one sperm nucleus unites with the egg and forms a zygote. This zygote develops into an embryo. The embryo grows for a short time and then becomes dormant. The other sperm nucleus unites with the polar nuclei and forms the endosperm, which is a mass of food-storing cells.

Surrounding the embryo and its endosperm is a protective coat that forms from ovule tissues. This package is a seed, which protects the dormant embryo until conditions are suitable for germination. The carpel, often with other parts of the flower, develops into a fruit around the seed or seeds.

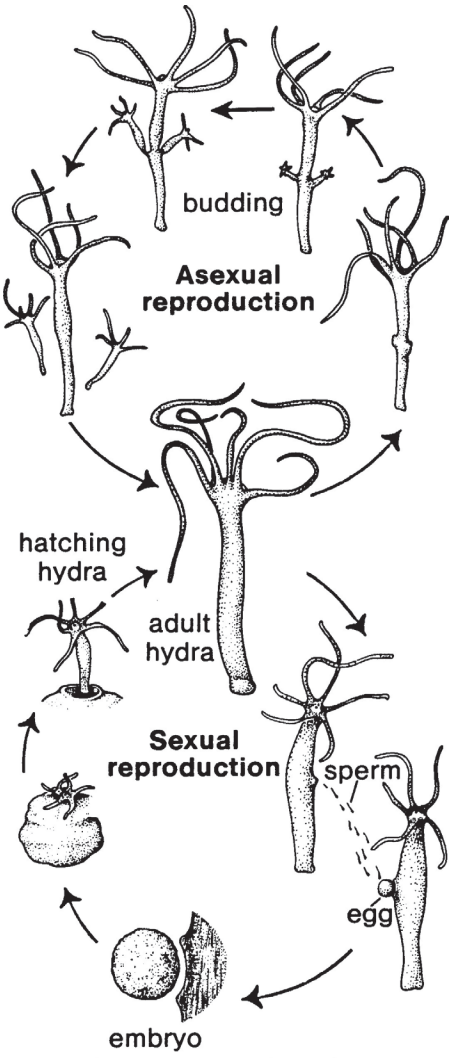


This type of reproduction involves alternation of generations because an asexual, spore-producing plant gives rise to a sexual, gamete-producing plant in the life cycle. Many flowering plants also can reproduce by using parts of the plant that are not specialized for reproduction. Strawberries, for example, send out horizontal stems, or runners, at the ends of which new plants grow. New potato plants sprout from potatoes, which are stems. And new plants sprout from the roots of many plants such as lilacs and aspen. Some plants even produce new plants along the leaf edges.

HYDRA (*Hydra* spp.)

Hydras are small (25 to 30 millimeters [about 1 inch]), freshwater animals that belong in the phylum Cnidaria, which are animals that have stinging tentacles. Other animals in this phylum include jellies and corals. Hydras normally live on the underside of aquatic leaves in cool, clean water of streams and ponds. Ten species exist in the United States.

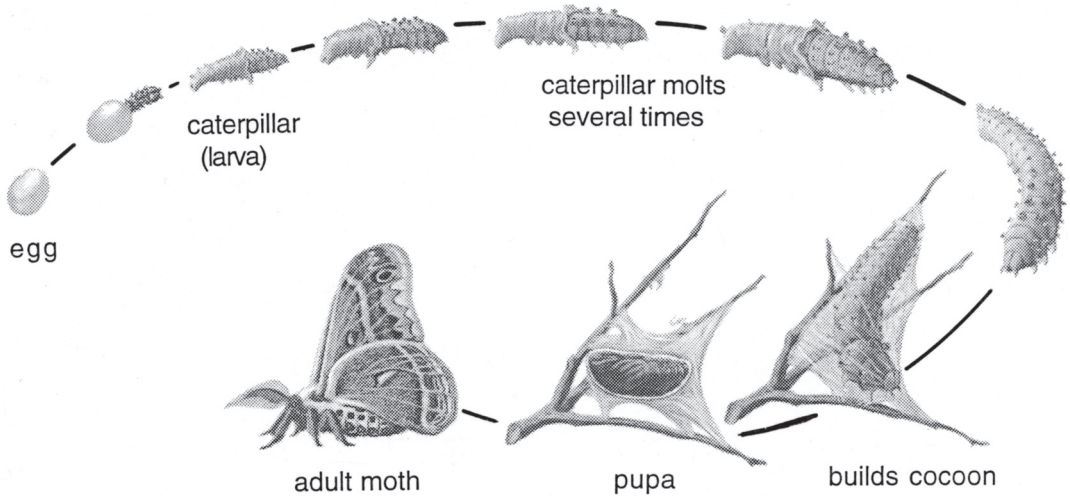
Throughout much of the year, these animals reproduce asexually by budding. The buds appear as outpocketings of the body wall and develop into young hydras that eventually detach from the parent. Under certain conditions, hydras produce both ovaries and testes. This is an adaptation for sexual reproduction that increases the chances of fertilization in attached or slow-moving animals. Eggs in the ovary are fertilized by sperm shed into the water. The resulting zygote develops into an embryo. Before it breaks loose from the parent, a cyst forms around the embryo that enables it to survive the winter. When the weather is favorable in the spring, a young hydra hatches out of the cyst.



CECROPIA MOTH (*Hyalophora cecropia*)

Cecropia moths are members of a family of night-flying moths that are found worldwide. Commonly called giant silkworm moths, some species spin a valuable silk, but it is not as fine as that of the Chinese silkworm from which most commercial silk is obtained. This family includes some of the largest insects; those in North America may have wingspans up to 15 centimeters (6 inches).

During mating, sperm are enclosed in a small sac that the male secretes and deposits in a small sperm-storage sac in the female. Ripe eggs have a large store of yolk and a fully formed shell. The shell contains a small opening. As an egg moves past the sperm-storage sac, several sperm enter the opening, but only one fuses with the egg nucleus and starts its development. The fertilized eggs are laid on various types of vegetation. An egg develops into a small larva, or caterpillar, in 10 days. The caterpillar is a voracious leaf eater. It sheds its outer covering four times and grows up to 10 centimeters (4 inches) in length in several weeks. It then spins a cocoon around itself, and the pupa develops within the cocoon. The adult moth emerges in the spring.

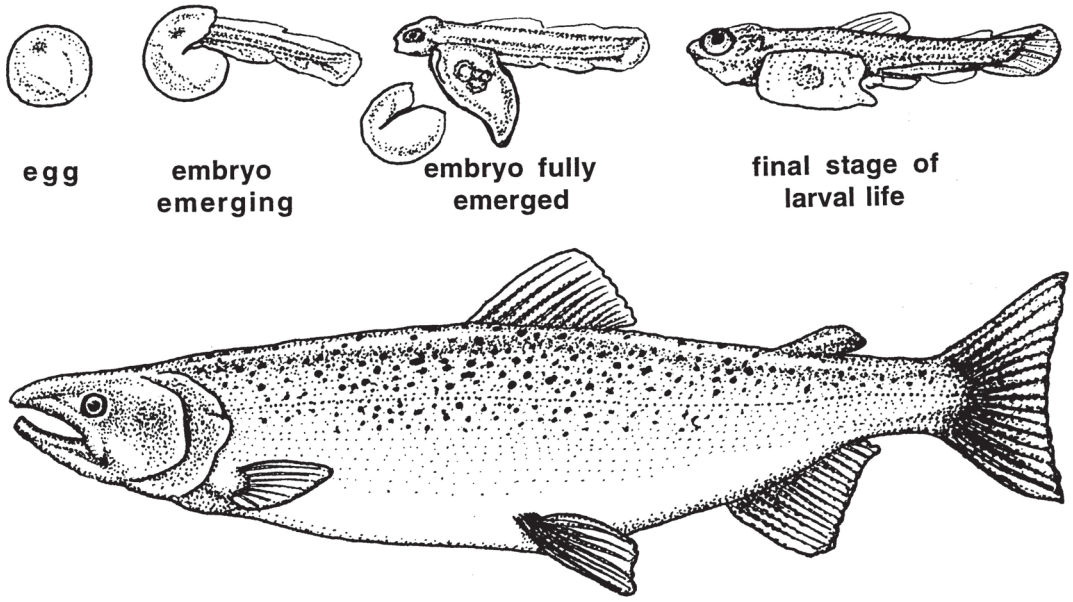


PACIFIC SALMON (example: pink salmon—*Oncorhynchus gorbuscha*)

Salmon is the common name of the fish family Salmonidae, which includes trouts, chars, and the salmons proper. There are six species of Pacific salmons, which range in mass from 1.4 to 6 kilograms (3 to 13 pounds), although king salmon average 10 kilograms (22 pounds) and may reach 36 kilograms (79 pounds). Pink salmon average 1.4 to 2.7 kilograms (3 to 6 pounds) and are 50 to 75 centimeters (20 to 30 inches) long. Salmon are silver-sided at sea but undergo color changes during the breeding season.

Pacific salmon spend their adult lives in the ocean and have a range of hundreds of miles. They return to fresh water (to the stream where they hatched) to reproduce. Most pink salmon reproduce near the sea, often in tidal flats, but other species of salmon migrate hundreds of miles. Some species perform a sort of mating dance after arriving at the spawning bed. To prepare for spawning, the female digs a pit in the stream gravel. She and the male spawn, or release their gametes, simultaneously. The female then covers the eggs with gravel. The adults die soon after spawning.

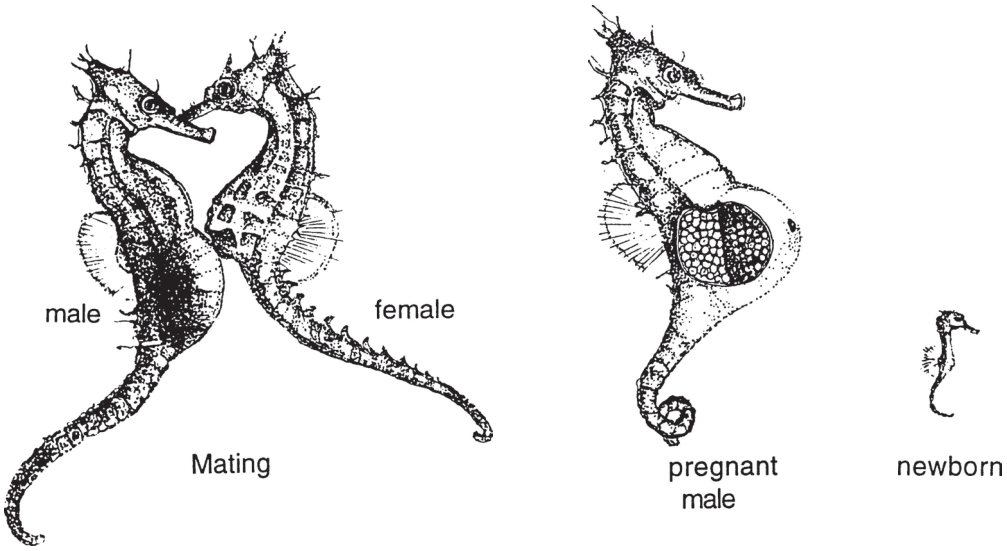
Spawning generally occurs in the fall when temperatures are dropping (pink salmon spawn in September and November), and the temperature is critical for spawning and for survival of the eggs and young. The eggs hatch in late winter, 60 to 200 days after spawning. The young, or fry, eat the yolk in the attached egg sac and then wriggle up through the gravel to seek food. Young pink salmon return to the sea immediately.



SEA HORSE (*Hippocampus abdominalis*)

The sea horse lives worldwide along coastal areas that have sea grass beds, mangroves, or coral reefs. There are close to 35 species that all belong to one genus, *Hippocampus*. Male sea horses are often more colorful, more aggressive, and more vocal than females. Unlike many animals, the male becomes pregnant and gives birth. Males are fiercely competitive for females. Males knock their rivals in the head with upward blows from their snouts. Males also tail wrestle. Often this is not a competitive behavior and the males let go of each other easily. But if they are competing for a mate, the pair might thrash about for a minute until one gives in by flattening himself on the sea bottom and turning a dark color.

Once a female/male pair has bonded, the pair remains monogamous until one dies or otherwise leaves the area. The male rocks about in front of his mate showing his empty pouch. The sea horses mate for only seconds as the female deposits as many as 200 eggs in the male's growing pouch. Inside the pouch, the eggs are fertilized, and each egg embeds in the soft tissue. Some species have only one membrane for eggs to attach to, and others have up to five membranes, which significantly increases the number of eggs that can attach to a membrane surface. After mating, the female visits the male each morning until the young are born about 21 days later. When the female arrives each morning, both members of the pair brighten in color. They spend 10 minutes twirling about with tails linked and then separate. Males are continuously pregnant throughout the breeding season.

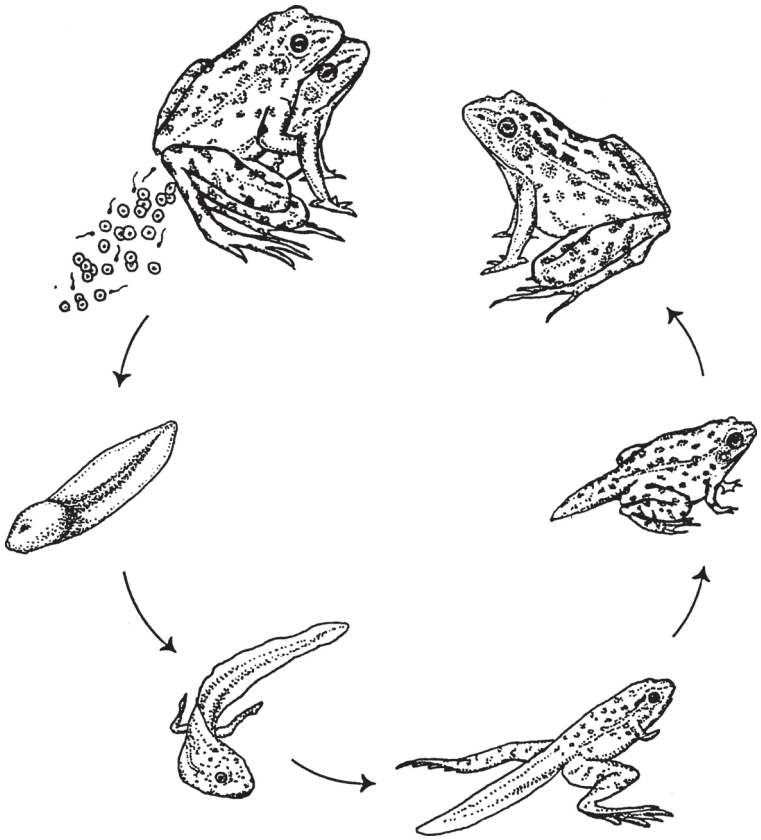


FROG (example: leopard frog—*Rana pipiens*)

Leopard frogs are amphibians that are predominantly aquatic. They have smooth, moist skin and strong, webbed hind feet that are adapted for swimming and leaping. They eat worms and insects. Adults are 5 to 9 centimeters (2 to 4 inches) long.

These frogs breed in freshwater ponds once a year. The male has a call that attracts the female. It seems that differences in the specific location of the calling male help maintain the species' identity. Females can distinguish between the calls of their own species and those of other species.

During mating, the male, which is smaller than the female, clasps the female from behind. This clasping by the male stimulates the female to lay hundreds of eggs. The male expels sperm over the eggs as the female ejects them. The fertilized eggs float off in dusters or sheets and may become attached to water plants. Egg laying occurs at night or early dawn in the spring and takes about 10 minutes. Tadpoles hatch from the eggs in a few days and change into tiny adult frogs in about 2 months. The young frogs grow and become sexually mature at about 3 years.

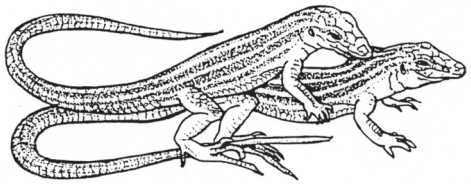


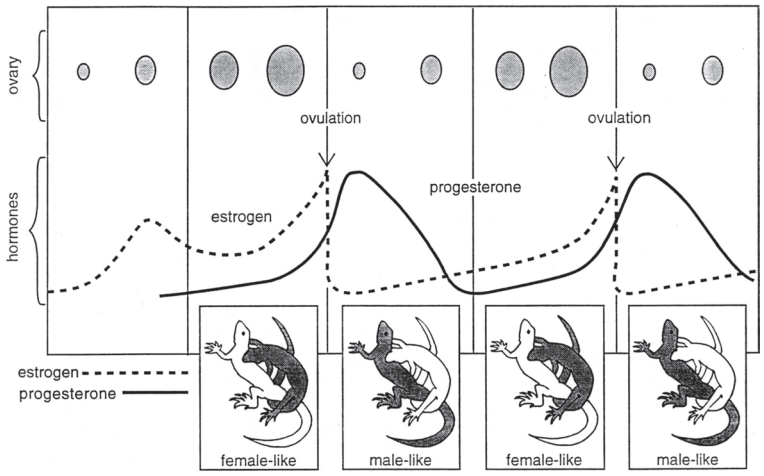
WHIPTAIL LIZARD (example: desert grassland whiptail lizard, *Cnemidophorus uniparens*)

This unusual species of lizard lives in the southwestern United States. It evolved from an ancestor that had male and female sexes. Today, all of the individuals in this species are anatomically females. However, individuals exhibit both male and female mating behaviors. These all-female whiptails reproduce by laying eggs that are not fertilized. This is possible because the unfertilized eggs duplicate their chromosomes, which mimics fertilization. The individuals of this species engage in mating behaviors that look the same as those between males and females of other species of whiptails, but for the all-female whiptails the behavior does not entail the fertilization of eggs. Scientists think that this behavior may, however, increase the number of eggs that an individual lays.

The female that is displaying malelike behavior will approach a female that is displaying femalelike behavior and explores her with "his" tongue. Then the "male" grabs the "female" by the skin of her neck with his jaw and mounts her. In a few minutes, he moves his tail under hers and eventually forms a doughnut shape by also moving his head to her pelvic region.

Scientists think that the malelike and femalelike behaviors may be determined by changes in the levels of the sex hormones. Before the eggs are released (ovulation), the individuals have high levels of estrogen and engage in femalelike behaviors. After ovulation, the estrogen levels drop off and there is a rapid increase in progesterone. When this change occurs, the individual switches to malelike behavior. This cycle repeats 2 or 3 times during the mating season.





In the beginning of the ovarian cycle of an individual, the ovaries are small, but they become larger as the eggs inside them mature and acquire more yolk. When the eggs are mature, they are released into the oviduct where they develop hard shells. While the eggs are developing shells, the ovaries prepare for another round of egg production. After 7 to 14 days, the individual lays this batch of eggs. This entire cycle lasts from 3 to 4 weeks. During the breeding season, the individuals synchronize their ovarian cycles. This means that in a pair of lizards, one individual is exhibiting femalelike behavior while the other is exhibiting malelike behavior.

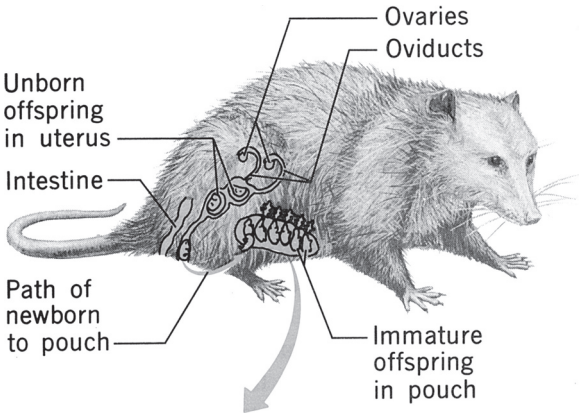
It is also interesting to note that in all-female species such as this, every individual lays eggs, and consequently, these populations grow much faster than populations in which only half of the individuals are laying eggs.

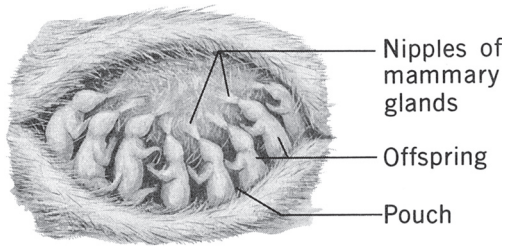
OPOSSUM (example: *Didelphis virginiana*)

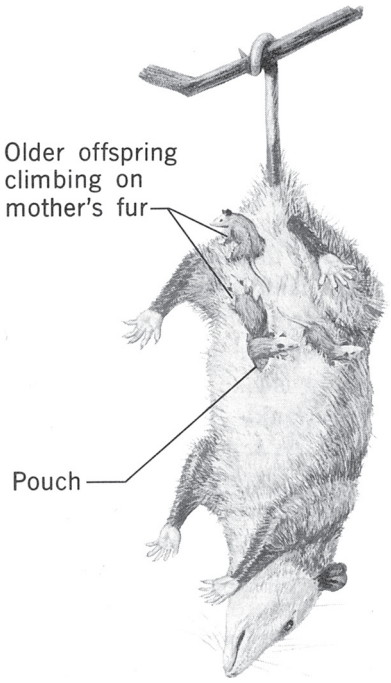
Opossums are marsupial mammals that nurse their offspring with milk while they are protected in a pouch. Opossums reach sexual maturity at about 5 months of age and weigh 1 to 4 kilograms (2 to 9 pounds). During mating, the male deposits sperm into the female, and the sperm fertilize a number of eggs. The zygotes develop into embryos. About 2 weeks later, the female has contractions for about 15 minutes as she gives birth to a litter of 3 to 13 very tiny (130 milligrams or 0.3 pound) young that are in an early stage of development. Within a few minutes, most of the young crawl to their mother's pouch and attach to a nipple. Generally, there are 13 nipples. Young that do not succeed in reaching the pouch or attaching to a nipple do not survive.

The young remain continually attached for 48 days, but do not emerge from the pouch for 60 days. At this time, they collectively may weigh more than the mother. From about 80 days, the young may be left in a den, and at about 86 days they begin to eat solid food and to ride on the mother's back. They are weaned at about 100 days.

Generally, opossums have two litters a year, but there may be only one litter in northern latitudes, and in southern latitudes, there may be more than two.



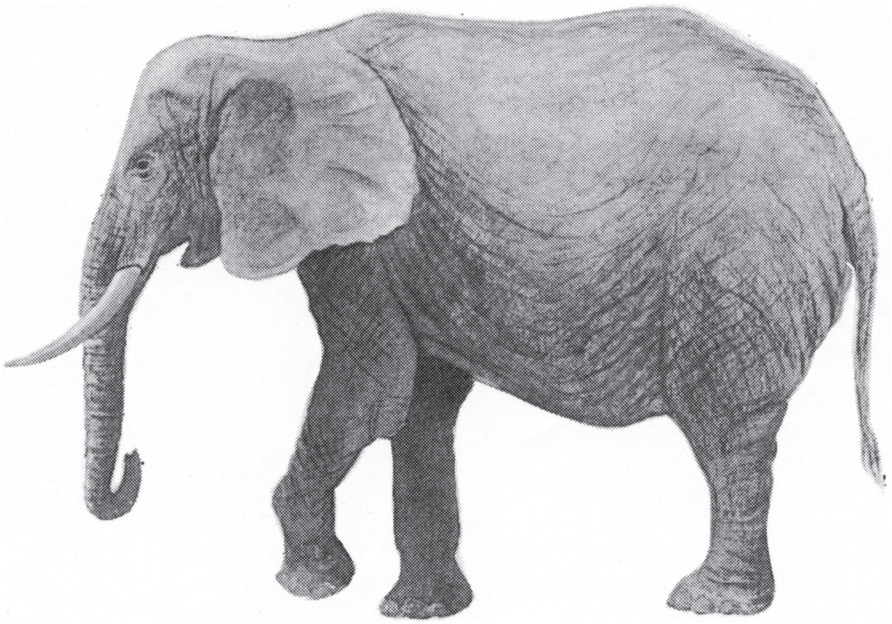




ELEPHANT (example: *Loxodonta africana*)

Except for whales, African elephants are the largest mammals living today. Adult bulls may reach 3.3 meters (10.8 feet) high at the shoulder and weigh 4,476 kilograms (5 tons). Females are somewhat smaller. Both sexes have tusks, which may weigh as much as 55 kilograms (121 pounds). They are fully grown at 25 years, and the average life span is 80 years. Elephants live in herds of 10 to 15 females and several young adult males with a large male as the leader. The young males serve as guards and scouts. Companionship and blood relationship hold the herd together. Members of the herd come to the assistance of an injured individual, and other cows in the herd will adopt a calf that has lost its mother. Elephants migrate with the wet and dry seasons and range great distances in search of food and water. The age of sexual maturity varies with the population density, ranging between 11 and 20 years for females and 14.5 and 19.5 years for males.

Tusked bulls sometimes fight duels to the death, and tuskless males may duel for days. The winner then selects a female from the herd and after a brief courtship mounts her from behind to deposit his sperm. Mating lasts about 20 seconds and continues periodically for 2 days. After mating, the bull drives off other males and stays with the cow for about 3 months. Just before birth, which occurs 20 to 22 months later, the herd surrounds the cow, who squats to give birth to a calf that is about 1 meter (3.28 feet) long and weighs 90 kilograms (198 pounds). Several elephants in the herd help the mother blow dust over the moist newborn to dry it; 2 hours later the calf can stand and suckle, after which the calf and its mother join the herd. Elephant cows can calve again in 3 to 9 years, but on average produce only four calves in a 50-year reproductive span. Species with a slow reproductive rate, like the elephant, are more vulnerable to extinction.



CHIMPANZEE (example: *Pan troglodytes*)

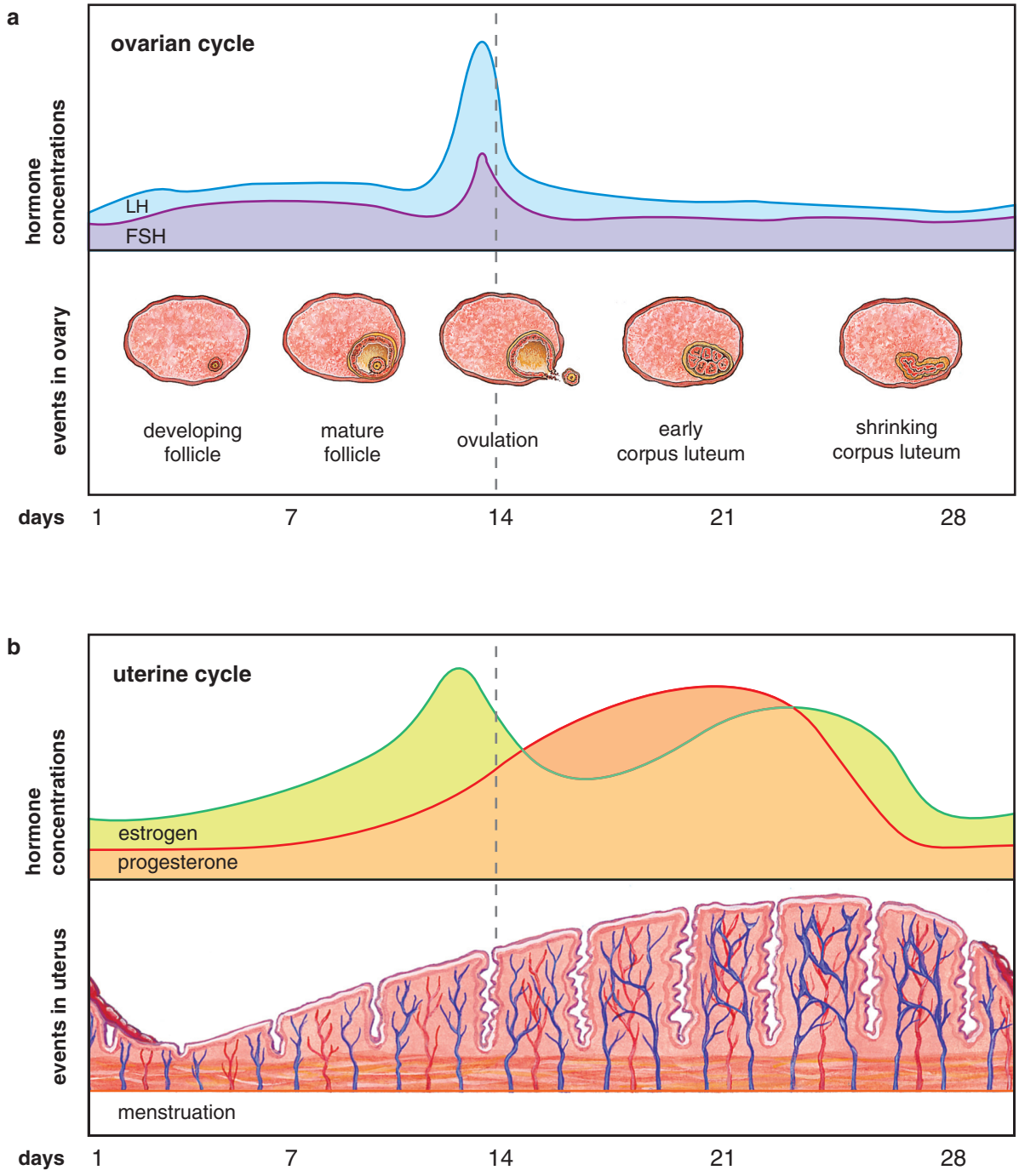
Chimpanzees inhabit Africa and live in loose communities of between 30 and 80 individuals. The most important factor in a community is whether or not there is a female ready for mating, which occurs throughout the year. A female's estrous cycle lasts about 36 days, and the females will mate for about 6 or 7 days during this period when they show the most genital swelling.

The gestation period averages about 230 days, and usually only one young is born. The average birth weight is about 1.9 kilograms (4 pounds). For the first 3 months of life, the infant is held by its mother. By about 6 months, the infant begins to cling to its mother and eventually rides on its mother's back. This lasts for several years. Infants and young chimps nurse until they are about 3 to 4 years old but are dependent on their mother much longer than that. An offspring still may be traveling with its mother when it is 10.

Puberty in both sexes occurs at about 7 years, but females do not give birth until they are 13 or 14. Many females leave the community into which they were born and join and mate with males in other communities. Females are capable of reproducing until they are 40 or so. The maximum life span in the wild seems to be about 60 years.

In the bonobo, another species of chimpanzee, males and females, young and old, tend to have many, brief sexual encounters with each other as a way of diffusing aggressive tendencies. Also in the bonobos, a female may be the dominant animal in a community.

Copymaster 10.2 *The Human Menstrual Cycle*



Dear Parent or Guardian:

Your son/daughter soon will begin Chapter 10, *Reproduction in Humans and Other Organisms*, in the biology course. This chapter, in accord with the rest of the course, approaches this topic in broad biological terms while using humans as a primary example. Because the concepts in this particular chapter touch on some areas that you may consider sensitive, we encourage you to review the material ahead of time.

The students in this course learn mainly by activities that allow them to explore and build an explanation for the biological topics they are studying. The fourth activity in Chapter 10 asks students to describe the biological explanations that underlie birth control technologies and fertility enhancement. The activity is not intended to promote the use of birth control. Instead, the activity provides an opportunity for students to be fully informed about the anatomy and physiology of human reproduction and the effect of reproductive technologies on various aspects of health and reproduction. This approach provides students with a concrete way to focus their explanation of the basic biological processes and regulatory mechanisms associated with reproduction. When this activity was field tested, it proved to be a powerful learning tool.

If you have any questions, concerns, or suggestions about the material after you have reviewed it, please contact me so that we may discuss the subject. Thank you for your interest in your child's education.

Sincerely,

Dear Parent or Guardian:

Your child is a student in my biology class. We are using a curriculum titled *BSCS Biology: A Human Approach*. As is typical in all biology programs, this curriculum includes a chapter on human reproduction. If you would like to review this chapter, or any others, please contact me. We will begin our work on this chapter _____.

Sincerely,

Copymaster 10.4 *Examples of Birth Control Methods*

Device or Method	Description	Failure Rate* (Pregnancies Per 100 Women Per Year)
Abstinence	Not having any sexual contact. (This is the only 100% effective way to prevent pregnancy, HIV, and other STDs.)	0
Cervical cap	A small, dome-shaped cup that is inserted through the vagina to closely cover the entrance to the uterus (cervix).	6–16
Condom (female)	A thin sheath made of nitrile (a type of plastic) or latex that is inserted into the vagina.	5–21
Condom (male)	A thin sheath made of latex or animal skin that is placed over the penis. It may be coated with spermicide. (*Only latex condoms* will help protect against HIV and other STDs.**)	2–15 (if spermicide is not used)***
Diaphragm	A shallow, dome-shaped cup made of latex with a flexible rim. It is placed over the entrance to the uterus (cervix). It is generally used with spermicide.	6–16 (if spermicide is not used)***
Implant	A thin rod that contains synthetic progesterone. It is inserted under the skin of a woman's upper arm. It releases hormones for 3–5 years.	1

Device or Method	Description	Failure Rate* (Pregnancies Per 100 Women Per Year)
Injection or "shot"	A shot of synthetic progesterone given to females. It lasts three months.	1–3
Intrauterine device (IUD)	A small plastic or copper device shaped in the form of a T. It is placed in the uterus by a doctor. It is effective for 10 years.	1
Natural family planning (rhythm method)	When a woman monitors and records data to determine when she ovulates during the month. She then abstains from sexual intercourse for several days around the time of ovulation.	1–25
Oral contraceptives (birth control pills)	A pill that is taken at the same time each day. It contains synthetic estrogen and synthetic progesterone (or progesterone only).	1–7
Patch	A patch that releases synthetic estrogen and progesterone into the bloodstream. It is worn on the lower abdomen, buttocks, or upper body.	1–8
Spermicide	Foam, cream, film, suppository, or tablet that is placed in the vagina before sexual activity. It contains chemicals that kill sperm.	18–29 (if used alone)
Tubal ligation (female sterilization)	When the oviducts in the female are surgically severed and tied off. This is a permanent form of birth control.	< 1
Vaginal contraceptive ring	A ring that is placed in the vagina. It releases synthetic estrogen and progesterone.	1–8
Vasectomy (male sterilization)	When the vasa deferentia in the male are surgically severed and tied off.	< 1

*Failure rate can be *much* higher if the method is not used properly. For example, if the condom is used *after* sexual contact has begun, some sperm may already have been released.

**"Natural" or lambskin condoms have larger pores than latex condoms. These condoms may allow pathogens, such as those that cause HIV or other STDs, to pass through the pores.

***Using spermicide with a condom or a diaphragm is more effective than using either of these methods alone.

Copymaster 10.5 *Birth Control Brochure Rubric*

Criteria	Excellent	Could Be Improved	Needs Substantial Improvement
Concept: Showing understanding of the big picture in this activity	Answers to questions provide evidence that the writer clearly understands the biological basis for birth control and fertility methods.	Answers to questions provide some evidence that the writer has a general understanding of the biological basis for birth control and fertility methods.	Answers to questions provide evidence that the writer has little understanding of the biological basis for birth control and fertility methods.
Explanation: Explanation for the human reproductive process, including specific evidence to support ideas	Brochure uses many specific examples and details taken from this activity to explain how different birth control methods interfere with reproduction in both males and females. Brochure accurately and clearly explains the roles that hormones play in regulating human reproduction.	Brochure uses general examples and information taken from this activity to explain how different birth control methods interfere with reproduction in both males and females. Brochure generally explains the roles that hormones play in regulating human reproduction.	Brochure lacks examples and details taken from this activity, or it incorrectly explains how different birth control methods interfere with reproduction in both males and females, or it does both. Brochure is overly brief or incorrectly explains the roles that hormones play in regulating human reproduction.
Presentation	Brochure is easy to read. Grammar and punctuation are used correctly, making it easy to understand what is meant. Brochure uses the correct scientific vocabulary in the appropriate context.	Brochure is fairly easy to read. Grammar and punctuation are generally used correctly. Sometimes it is difficult to be sure what is meant. Brochure uses some scientific vocabulary, and it is in the appropriate context.	Brochure is difficult to read. Grammar and punctuation are frequently used incorrectly. Often, it is difficult to be sure what is meant. Brochure either does not use any scientific vocabulary or uses it incorrectly.

Evaluate: A Reproductive Strategy for Your Critter

Copymaster 10.6 *Your Critter's Reproductive Strategy Rubric*

Criteria	Excellent	Could Be Improved	Needs Substantial Improvement
Concept: Showing understanding of the big picture in this chapter	Paragraphs describing the reproductive strategy clearly show the writer's understanding that these particular reproductive strategies work to ensure biological continuity for this species.	Paragraphs describing the reproductive strategy show that the writer generally understands that these particular reproductive strategies work to ensure biological continuity for this species.	Paragraphs describing the reproductive strategy are brief and don't explain how the strategy relates to biological continuity for this species.
Explanation: Explanation for reproduction, including specific evidence to support ideas	Description of the critter's reproductive strategy includes an explanation of the advantages and disadvantages for the number of offspring produced, their approximate life spans, and the nurturing they receive. These characteristics are explained in terms of the critter's average life span and habitat. Description of the critter's reproductive strategy explains how the timing of the reproductive cycle is controlled through a combination of hormones and environment. The timing is logical for this critter.	Description of the critter's reproductive strategy includes a general explanation for the number of offspring produced, their approximate life spans, and the nurturing they receive. These characteristics are briefly explained in terms of the critter's average life span and habitat. Description of the critter's reproductive strategy provides a general explanation for the timing of the reproductive cycle. It needs to include more-specific explanations for how that timing is controlled and why that timing is necessary to show that the writer understands this aspect of reproduction.	Description of the critter's reproductive strategy lacks an explanation of, or gives an incorrect explanation for, the advantages and disadvantages for the number of offspring produced, their approximate life spans, or the nurturing they receive. Little or no mention is made of the critter's average life span and habitat. Description of the critter's reproductive strategy makes little or no mention of how the reproductive cycle is controlled.

Criteria	Excellent	Could Be Improved	Needs Substantial Improvement
Explanation: Comparison to human reproduction, including specific evidence to support ideas	Writer shows clear understanding of human reproduction by comparing the similarities and differences with the critter's reproductive strategy. Specific references to reproductive structures, hormones, and mating strategies demonstrate the writer's knowledge.	Writer shows a general understanding of human reproduction by comparing the similarities and differences with the critter's reproductive strategy. More-specific references to reproductive structures, hormones, and mating strategies are needed to show the writer's knowledge. Some descriptions of human reproduction are incorrect.	Writer shows little understanding of human reproduction. Few or incorrect references to reproductive structures, hormones, and mating strategies are given.
Creativity	Critter's reproductive strategy is imaginative and well suited to reproductive success. Critter is clearly the result of some careful thought and creativity.	Critter's reproductive strategy is imaginative and well suited to reproductive success, but it lacks attention to detail.	Critter's reproductive strategy does not demonstrate much time or effort on the writer's part: few details were imagined or thoroughly described.
Presentation	Drawings, diagrams, and descriptions make it easy for any reader to imagine how this critter's reproductive strategy ensures biological continuity for its species.	Drawings, diagrams, and descriptions give a pretty good sense of how this critter's reproductive strategy ensures biological continuity for its species.	Drawings, diagrams, and descriptions were done too hastily to include all the details that would give readers a clear idea of how this critter's reproductive strategy ensures biological continuity for its species.